OFFICIAL

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re the Application of

Goldberg (TI-25588) Appeal No. 2002-2070

Serial No. 09/085,298 Group Art Unit: 2822

Filed: May 27, 1998 Examiner: K. Duang

For: Method for Thermal Nitridation and/or Oxidation of Semiconductor Surface and Related Processing Equipment

SUPPLEMENTAL REPLY BRIEF

Board of Patent Appeals and Interferences
Under Secretary of Commerce for Intellectual Property
and Director of the United States Patent and Trademark Office
Washington, DC 20231

In response to the Supplemental Examiner's Answer mailed March 10, 2004, Appellant respectfully presents his Supplemental Reply Brief in further support of his appeal in this application.

Appellant maintains the arguments presented in Appellant's Brief filed June 18, 2001 and in the Reply Brief filed March 28, 2002. This Supplemental Reply Brief is directed only to those points of argument that were raised by the Examiner in the Supplemental Examiner's Answer, as instructed by the Board of Patent Appeals and Interferences in its Remand to the Examiner on August 21, 2003.

In the Remand, the Board instructed the Examiner to respond to Appellant's assertion that "one can readily surmise that the amount of oxygen released from the quartz tube is insufficient to oxidize the silicon, or that the oxygen released from the quartz tube is produced

too late in the process (i.e., after the silicon nitride is already formed) to reach and oxidize the silicon", specifically whether "the oxygen released from the quartz tube is produced too late in the process (i.e., after the silicon nitride is already formed) to reach and oxidize the silicon".[1] The Examiner addressed this point by arguing that this issue is directed to a limitation that is argued but not claimed, and by further arguing that the Nozaki et al. reference[2] in fact teaches the presence of oxygen prior to the formation of the silicon nitride film.

Appellant will address these arguments in sequence.

Argued but not claimed

In the Supplemental Examiner's Answer, the Examiner characterizes Appellant's argument as arguing "that the Nozaki et al. reference fails to disclose providing sufficient amount of oxygen to oxidize the silicon-containing structure after the silicon nitride is formed".[3] The Examiner then finds that the claims nowhere require this limitation in the claims, or any limitation "relating to the time in the process when oxygen is released to reach and oxidize the silicon".[4] The upshot of the Examiner's statement is that the argument raised by Appellant is not relevant to the claims on appeal.

This characterization of Appellant's argument is simply not correct.

First, nowhere does Appellant make the assertion that the Examiner finds to be irrelevant. To quote the assertion of Appellant's Reply Brief that most closely resembles the Examiner's assertion:

> There is no teaching from the Nozaki et al. reference or from extrinsic evidence that the oxygen contaminant of the reference is present in sufficient amount, or at the appropriate time in the process, or even in a chemically combinable or active form, to cause oxidation of the underlying silicon surface.[5]

---

[1] Remand of August 21, 2003, p. 3.
[2] U.S. Patent No. 4,298,629 to Nozaki et al.
[3] Supplemental Examiner's Answer of March 10, 2004, p. 3.
[4] *Id.*
[5] Reply Brief of March 28, 2002, p. 3.

Appellant simply has never argued that the reference "fails to disclose providing sufficient amount of oxygen to oxidize the silicon-containing structure after the silicon nitride is formed", as asserted by the Examiner in the Supplemental Answer. The Examiner's side-stepping of the issue on remand, by finding that Appellant is arguing a limitation that is not claimed, is therefore itself irrelevant and misplaced.

Second, Appellant submits that the issue that the Board remanded to the Examiner is indeed relevant to the claims on appeal.

Appellant previously argued that each of the claims on appeal require the providing of a gas comprised of a mixture of nitrogen and oxygen, which the Nozaki et al. reference fails to disclose. The Examiner asserted, in response, that oxygen from the quartz tube disclosed in the Nozaki et al. reference would inherently incorporate with the disclosed nitrogen-containing gas resulting in a gas comprised of a mixture of nitrogen and oxygen,[6] and that thermal nitridation and thermal oxidation of the underlying structure results from subsequent heating of the silicon-containing structure in this gas mixture, as taught by the Wolf reference.[7] It is this inherency argument to which Appellant's arguments, regarding whether oxygen contaminant of the reference is present in sufficient amount, or at the appropriate time in the process, or even in a chemically combinable or active form, to cause oxidation of the underlying silicon, are directed.

At the risk of belaboring the point, the law requires that inherency be established by extrinsic evidence that clearly shows that "the missing descriptive matter is necessarily present in the thing described in the reference, and that it would be so recognized by persons of ordinary skill."[8] In the context of examination by the Patent and Trademark Office, an Examiner must "provide a basis in fact and/or technical reasoning to reasonably support the determination that the allegedly inherent characteristic *necessarily* flows from the teachings of

---

[6] Examiner's Answer, January 29, 2002, page 5.
[7] Wolf et al., *Silicon Processing for the VLSI Era*, Vol. 1, p. 300.
[8] *In re Robertson*, 169 F.3d. 743, 49 USPQ2d 1949 (Fed. Cir. 1999), F.3d at 745, *citing Continental Can Co. v. Monsanto Co.*, 948 F.2d 1264, 1268, 20 USPQ2d 1746, 1749 (Fed. Cir. 1991).

the applied prior art."[9] In this case, there is neither factual basis nor technical reasoning that supports the Examiner's position that the oxygen from the decomposition of the quartz tube in the Nozaki et al. reference *necessarily* incorporates with nitrogen-containing gas to provide a gas comprised of a mixture of nitrogen and oxygen, so that thermal nitridation and thermal oxidation of the underlying structure *necessarily* results from subsequent heating of the silicon-containing structure in this gas mixture.

First, there is no teaching in the Nozaki et al. reference that any oxygen is necessarily present as a gas with nitrogen, or in such a form or at a time that oxidation will necessarily result. The reference teaches that there is an oxygen concentration in the silicon nitride film that is formed, and that the quartz reaction tube is a source of that oxygen. But the reference nowhere discloses that this oxygen is gaseous, or in a reactive form that can oxidize the underlying silicon.

Second, reasonable alternative explanations preclude a finding that the oxygen present in the Nozaki et al. silicon nitride film has *necessarily* oxidized its silicon. The Nozaki et al. reference itself expressly teaches that oxygen concentration in its silicon nitride film "includes the oxygen which is adsorbed on the surface of the silicon nitride films as foreign matter."[10] This statement, in and of itself, is sufficient to show that the oxygen present in the nitride film did not necessarily oxidize the underlying silicon. The Nozaki et al. reference also teaches that a silicon nitride film can be subsequently oxidized[11] (as distinguished from oxidation of the underlying silicon during formation of the nitride). And as previously argued, perhaps the amount of oxygen released from the quartz tube according to the Nozaki et al. reference is insufficient to oxidize the silicon. Perhaps the oxygen released from the quartz tube is produced too late in the process (i.e., after the silicon nitride is already formed) to reach and oxidize the silicon. Perhaps the oxygen may be present in the form of quartz particles or molecules released from the reaction tube itself, rather than as oxygen in a form that can oxidize (or has oxidized) the silicon. Any of these possible explanations could explain the presence of

[9] *In re Levy*, 17 USPQ 2d 1461 (Bd. Pat. App. & Interf. 1990) (emphasis added).
[10] Nozaki et al., *supra*, column 6, lines 20 through 22.
[11] Nozaki et al., *supra*, column 9, lines 3 through 7.

oxygen concentration in the silicon nitride film of the Nozaki et al. reference, without necessarily meaning that the oxygen was capable of oxidizing the underlying silicon. The Nozaki et al. reference itself does not preclude any of these explanations, and in fact teaches at least one of them (oxygen is adsorbed, as foreign matter, at the surface of the nitride film).

Therefore, there is no basis in fact nor technical reasoning presented that reasonably supports a determination that, according to the Nozaki et al. teachings, oxygen from the quartz tube *necessarily* incorporates with the disclosed nitrogen-containing gas to provide a gas comprised of a mixture of nitrogen and oxygen, so that thermal nitridation and thermal oxidation of the underlying structure *necessarily* results from subsequent heating of the silicon-containing structure in this gas mixture.

The Nozaki et al. reference does not teach presence of the oxygen prior to nitridation

The Supplemental Examiner's Answer asserts that the Nozaki et al. reference, at lines 9 through 12 of its column 7, discloses "that a high concentration of nitrogen and a low concentration of oxygen are already present at the surface of the silicon substrate prior to a thermal processing step to form a silicon nitride dielectric layer".[12] The Examiner uses this interpretation of the teachings of the reference to support an argument that thermal nitridation and thermal oxidation of the silicon substrate must necessarily occur in the subsequent thermal processing step.

Appellant respectfully submits that the cited location of the reference does not disclose that oxygen is already present at the surface of the silicon substrate prior to the thermal nitridation processing step. The location of the reference cited by the Examiner refers to the Auger analysis of its Figure 5, which is expressly stated to be an Auger of a silicon nitride film that "*was formed* by the method of the present invention".[13] Given the express teaching in the reference itself that oxygen is "adsorbed on the surface of the silicon nitride films as foreign matter", it is reasonable to conclude that it is this adsorbed oxygen on the surface of the silicon

[12] Supplemental Examiner's Answer, *supra*, carryover paragraph from page 3 to page 4.
[13] Nozaki et al., *supra*, column 6, lines 63 through 65 (emphasis added).

nitride film that appears in the Auger analysis of Figure 5. Indeed, if one correlates Auger bombardment time with depth into the silicon nitride film, it appears from Figure 5 that the oxygen resides only at the surface of the nitride film, with substantially no oxygen exhibited at bombardment times well into the film (where both silicon and nitrogen are still exhibited).

Regarding the cited statement in the reference that it is apparent from Figure 5 that "silicon is combined with a high concentration of the nitrogen and a low concentration of the oxygen at the surface of the FZ substrate subjected to the direct thermal nitridation"[14], Appellant submits that this statement does not teach that oxygen is in fact present at this surface prior to nitridation. First, the phrase "at the surface of the FZ substrate subjected to the direct thermal nitridation" does not necessarily mean "at the surface of the FZ substrate *when it is* subjected to the direct thermal nitridation". The phrase "subjected to the direct thermal nitridation" may instead simply further *describe* the substrate. For example, the cited statement may instead mean "at the surface of the FZ substrate *that was* subjected to the direct thermal nitridation". There is no unequivocal temporal reference in the cited statement.

Second, there is no unequivocal reference in the cited statement that the silicon is oxidized by this low concentration of oxygen. The Auger analysis of Figure 5 shows oxygen, nitrogen, and silicon peaks, which shows that the elements of oxygen, nitrogen, and silicon are present in the film. If, as taught by the reference itself, the oxygen concentration in its silicon nitride film "includes the oxygen which is adsorbed on the surface of the silicon nitride films as foreign matter"[15], this too would be a combination of silicon with a high concentration of nitrogen and a low concentration of oxygen, and would show oxygen, nitrogen, and silicon Auger peaks. The cited statement is therefore not an unequivocal statement that the oxygen was present in a form and at a time to oxidize the silicon, as the Examiner asserts would *necessarily* occur.

---

[14] Nozaki et al., *supra*, column 7, lines 9 through 12.
[15] Nozaki et al., *supra*, column 6, lines 20 through 22.

Third, the overall goal of the Nozaki et al. teachings is to reduce the oxygen concentration in the silicon nitride film.[16] The reference nowhere states that it is desirable to have some (but not much) oxygen combining with the silicon. In the context of the Nozaki et al. reference, the lower the oxygen concentration in the silicon nitride film, the better. One gathers, from the reference, that zero oxygen concentration in the silicon nitride film would be best of all. Accordingly, one cannot interpret the cited statement of the reference as teaching that *some* oxygen *is* present at the surface of the substrate at the initiation of the direct thermal nitridation. Instead, given its context, the better interpretation of the cited statement is that *at most a low concentration* of oxygen is present. But again, the questions of when this oxygen is present, and in which form this oxygen is present, remain unanswered.

Finally, the Examiner's interpretation of the cited statement does not make sense in connection with the asserted inherency theory. The Examiner asserted, as mentioned above, that oxygen from the quartz reaction tube inherently incorporates with the disclosed nitrogen-containing gas resulting in a gas comprised of a mixture of nitrogen and oxygen. But there is no teaching from the reference that this alleged oxygen out-gasses from the quartz reaction tube before the disclosed thermal nitridation begins. Rather, as mentioned in the reference itself,[17] oxygen concentration results from the reaction of ammonia and the quartz reaction tube. Accordingly, under the Examiner's own theory, oxygen cannot be present at the silicon surface *before* the reaction begins, because the oxygen is provided by decomposition of the quartz tube *during* the reaction.

For these reasons, Appellant submits that the Nozaki et al. reference, as properly interpreted, neither expressly nor inherently discloses the providing of a gas comprised of a mixture of oxygen and nitrogen, which in a plasma causes thermal nitridation and thermal oxidation of a portion of a structure or substrate.

---

[16] *See* Nozaki et al., *supra*, column 3, lines 3 through 6; column 6, lines 46 through 58;
[17] Nozaki et al., *supra*, column 2, lines 35 through 38.

Conclusion

For these additional reasons, and for the reasons previously stated in Appellant's Brief and Appellant's Reply Brief, Appellant respectfully maintains that the final rejection of claims 1 through 5, 7 through 10, and 13 under §103, is in error. Reversal of the final rejection is therefore respectfully requested.

Respectfully submitted,

Rodney M. Anderson
Registry No. 31,939
Attorney for Appellant

Anderson, Levine & Lintel, L.L.P.
14785 Preston Road, Suite 650
Dallas, Texas 75254
(972) 664-9554

CERTIFICATE OF FACSIMILE TRANSMISSION
37 C.F.R. 1.8
The undersigned hereby certifies that this correspondence is being facsimile transmitted to the Patent and Trademark Office (Fax Number 703-872-9306) on April 30, 2004.

Rodney M. Anderson
Registry No. 31,939

To: Technology Center 2822
Facsimile Number: 703.872-9306

Total Pages Sent 9

From: **Rodney M. Anderson**
Anderson, Levine, and Lintel
(fax) 972.664.9606
(voice) 972.664.9554

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re the Application of

Goldberg
Serial No.: 09/085,298
Filed: May 27, 1998

Appeal Number 2002-2070
Docket Number: TI-25588
Art Unit: 2822
Examiner: K. Duang

For: Method for Thermal Nitridation and/or Oxidation of Semiconductor Surface and Related Processing Equipment

CERTIFICATION OF FACSIMILE TRANSMISSION

I hereby certify that the following papers are being transmitted by facsimile to the U.S. Patent and Trademark Office at **703.872.9306** on the date shown below:

30 April 2004

Rodney M. Anderson

FACSIMILE COVER SHEET

X FACSIMILE COVER SHEET	___ AMENDMENT _____
___ NEW APPLICATION	___ EOT _____
___ DECLARATION	___ NOTICE OF APPEAL
___ ASSIGNMENT	___ APPEAL _____
___ FORMAL DRAWINGS	___ ISSUE FEE
___ INFORMAL DRAWINGS	X SUPPLEMENTAL REPLY BRIEF
___ CONTINUATION APP'N	___ FEE TRANSMITTAL (1 page)
___ DIVISIONAL APP'N	

NAME OF INVENTOR(S): Goldberg	RECEIPT DATE & SERIAL NO.: **Serial No.: 09/085,298** **Filing Date: 5/27/1998**
TITLE OF INVENTION: Method for Thermal Nitridation and/or Oxidation of Semiconductor Surface and Related Processing Equipment	
TI FILE NO.: TI-25588 / DEPOSIT ACCT. NO.: **20-0668**	
FAXED: 30 April 2004 DUE: 10 May 2004 ATTY/SEC'Y: ALL/RMA	